1. A homogenous charge compression ignition barrel engine comprising:

An engine housing having a first end and a second end;

a elongated power shaft longitudinally disposed in the engine housing and defining a longitudinal axis of the engine;

a plurality of cylinders surrounding the longitudinal axis, each cylinder having a closed end and an open end, each cylinder having a central axis, the open ends of the cylinders each being generally directed toward the first end of the housing;

an intake system operable to introduce a combustible mixture of air and fuel into each of the cylinders;

a track disposed between the first end of the housing and the open ends of the cylinders such that a portion of the track is disposed generally in alignment with the central axis of each of the cylinders, the track having a cam surface that longitudinally undulates with respect to the open ends of the cylinders, a portion of the cam surface being disposed generally in alignment with the central axis of each of the cylinders, the track and the cylinders being rotatable with respect to each other such that the undulating cam surface moves with respect to the open ends of the cylinders; and

a piston movably disposed in each of the cylinders such that a combustion chamber is defined between the piston and the closed end of the cylinder, each piston being in mechanical communication with the cam surface of the track such that as the cylinders and track move with respect to each other, the pistons reciprocate within the cylinders, each piston being operable to compress the combustible mixture until the mixture autoignites, without the introduction of a spark.

2. The engine according to claim 1, further comprising a variable compression ratio device operable to adjust the longitudinal position of the track with respect to the open ends of the cylinders such that the compression ratio of the engine is adjusted.

3. The engine according to claim 1, wherein the central axis of each of the cylinders is parallel to the longitudinal axis of the engine.

4. The engine according to claim 1, wherein the track is disposed generally in a plane that is perpendicular to the longitudinal axis of the engine and the cam surface is disposed at a generally constant distance from the longitudinal axis of the engine.

5. The engine according to claim 1, wherein the track is in mechanical communication with the power shaft such that the shaft and track rotate in unison with respect to the cylinders.

6. The engine according to claim 1, wherein the track is in mechanical communication with the engine housing such that the track and the engine housing do not rotate with respect to each other, the cylinders and the power shaft being in mechanical communication such that the cylinders and power shaft rotate in unison with respect to the engine housing.

7. The engine according to claim 1, further comprising a water injection system operable to selectively introduce water into the cylinders, to thereby alter the combustion phasing for the cylinders.

8. The engine according to claim 7, wherein the water injection system comprises discrete water injectors for selectively introducing different amounts of water into different ones of the cylinders, to thereby alter the relative combustion phasing of the different ones of the cylinders.

9. The engine according to claim 1, wherein the undulating cam surface defines a generally sinusoidal shape.

10. The engine according to claim 1, wherein the undulating cam surface defines a non-sinusoidal shape.

11. The engine according to claim 10, wherein the cam surface includes at least one top dead center portion, the top dead center portion being linearly shorter than if the cam surface defined a sinusoidal shape.

12. The engine according to claim 10, wherein the cam surface defines at least one compression stroke and one expansion stroke, the compression stroke being slower and the expansion stroke being faster than if the cam surface defined a sinusoidal shape.

13. The engine according to claim 1, wherein the intake system includes intake and exhaust valves operable to open and close to controllably allow intake and exhaust to enter and exit the cylinders, the opening and closing time of the intake valves and the exhaust valves being controllably adjustable with respect to the rotational position of the track with respect to the cylinders.

14. The engine according to claim 1, further comprising:

a second plurality of cylinders disposed between the track and the first end of the housing, each of the cylinders having a closed end and an open end, the open ends of the cylinders each being generally directed toward the second end of the housing; and

a piston movably disposed in each of the second plurality of cylinders such that a combustion chamber is defined between the piston and the closed end of the cylinder, each piston being in mechanical communication with the cam surface of the track such that as the cylinders and track move with respect to each other, the pistons reciprocate within the cylinders.

15. The engine according to claim 14, wherein the second plurality of cylinders and the pistons therein comprise a supercharger for compressing air to be used for the combustible mixture.

16. The engine according to claim 14, further comprising an intake system operable to introduce a combustible mixture of air and fuel into each of the cylinders in the second plurality, and wherein each piston disposed in the second plurality of cylinders is operable to compress the combustible mixture until the mixture autoignites, without the introduction of a spark.

17. A method of converting fuel and air into rotational energy comprising the steps of:

providing a homogenous charge compression ignition barrel engine comprising:

an engine housing having a first end and a second end;

a elongated power shaft longitudinally disposed in the engine housing and defining a longitudinal axis of the engine;

a plurality of cylinders surrounding the longitudinal axis, each cylinder having a closed end and an open end, each cylinder having a central axis, the open ends of the cylinders each being generally directed toward the first end of the housing;

a track disposed between the first end of the housing and the open ends of the cylinders such that a portion of the track is disposed generally in alignment with the central axis of each of the cylinders, the track having a cam surface that longitudinally undulates with respect to the open ends of the cylinders, a portion of the cam surface being disposed generally in alignment with the central axis of each of the cylinders, the track and the cylinders being rotatable with respect to each other such that the undulating cam surface moves with respect to the open ends of the cylinders; and

a piston movably disposed in each of the cylinders such that a combustion chamber is defined between the piston and the closed end of the cylinder, each piston being in mechanical communication with the cam surface of the track such that as the

cylinders and track move with respect to each other, the pistons reciprocate within the cylinders between an upper position and a lower position;

rotating the track so as to position one of the pistons in the upper position;

continuing to rotate the track such that the one piston moves between the upper position and the lower position;

introducing a combustible mixture of air and fuel into the combustion chamber as the piston moves between the upper and the lower position;

continuing to rotate the track such that the one piston moves between the lower position and the upper position and the combustible mixture is compressed;

compressing the combustible mixture until the mixture autoignites without the introduction of a spark, such that the mixture combusts; and

using the combustion of the mixture to move the piston between the upper position and the lower position, thereby causing the track to rotate.

18. A variable compression ratio homogenous charge compression ignition barrel engine comprising:

an engine housing having a first end and a second end;

a elongated power shaft longitudinally disposed in the engine housing and defining a longitudinal axis of the engine;

a plurality of cylinders surrounding the longitudinal axis, each cylinder having a closed end and an open end, each cylinder having a central axis, the open ends of the cylinders each being generally directed toward the first end of the housing;

an intake system operable to introduce a combustible mixture of air and fuel into each of the cylinders;

a track disposed between the first end of the housing and the open ends of the cylinders such that a portion of the track is disposed generally in alignment with the central axis of each of the cylinders, the track having a cam surface that longitudinally undulates with respect to the open ends of the cylinders, a portion of the cam surface being disposed generally in alignment with the central axis of each of the cylinders, the

track and the cylinders being rotatable with respect to each other such that the undulating cam surface moves with respect to the open ends of the cylinders;

a piston movably disposed in each of the cylinders such that a combustion chamber is defined between the piston and the closed end of the cylinder, each piston being in mechanical communication with the cam surface of the track such that as the cylinders and track move with respect to each other, the pistons reciprocate within the cylinders, each piston being operable to compress the combustible mixture until the mixture autoignites, without the introduction of a spark; and

a variable compression ratio device operable to adjust the longitudinal position of the track with respect to the open ends of the cylinders such that the compression ratio of the engine is adjusted.

19. The engine according to claim 18, wherein the central axis of each of the cylinders is parallel to the longitudinal axis of the engine.

20. The engine according to claim 18, wherein the track is disposed generally in a plane that is perpendicular to the longitudinal axis of the engine and the cam surface is disposed at a generally constant distance from the longitudinal axis of the engine.

21. The engine according to claim 18, wherein the track is in mechanical communication with the power shaft such that the shaft and track rotate in unison with respect to the cylinders.

22. The engine according to claim 18, wherein the track is in mechanical communication with the engine housing such that the track and the engine housing do not rotate with respect to each other, the cylinders and the power shaft being in mechanical communication such that the cylinders and power shaft rotate in unison with respect to the engine housing.

23. The engine according to claim 18, further comprising a water injection system operable to selectively introduce water into the cylinders, to thereby alter the combustion phasing for the cylinders.

24. The engine according to claim 23, wherein the water injection system comprises discrete water injectors for selectively introducing different amounts of water into different ones of the cylinders, to thereby alter the relative combustion phasing of the different ones of the cylinders.

25. The engine according to claim 18, wherein the undulating cam surface defines a generally sinusoidal shape.

26. The engine according to claim 18, wherein the undulating cam surface defines a non-sinusoidal shape.

27. The engine according to claim 26, wherein the cam surface includes at least one top dead center portion, the top dead center portion being linearly shorter than if the cam surface defined a sinusoidal shape.

28. The engine according to claim 26, wherein the cam surface defines at least one compression stroke and one expansion stroke, the compression stroke being slower and the expansion slope being faster than if the cam surface defined a sinusoidal shape.

29. The engine according to claim 18, wherein the intake system includes intake and exhaust valves operable to open and close to controllably allow intake and exhaust to enter and exit the cylinders, the opening and closing time of the intake valves and the exhaust valves being controllably adjustable with respect to the rotational position of the track with respect to the cylinders.

30. A method of converting fuel and air into rotational energy comprising the steps of:

providing a variable compression ratio homogenous charge compression ignition barrel engine comprising:

an engine housing having a first end and a second end;

a elongated power shaft longitudinally disposed in the engine housing and defining a longitudinal axis of the engine;

a plurality of cylinders surrounding the longitudinal axis, each cylinder having a closed end and an open end, each cylinder having a central axis, the open ends of the cylinders each being generally directed toward the first end of the housing;

a track disposed between the first end of the housing and the open ends of the cylinders such that a portion of the track is disposed generally in alignment with the central axis of each of the cylinders, the track having a cam surface that longitudinally undulates with respect to the open ends of the cylinders, a portion of the cam surface being disposed generally in alignment with the central axis of each of the cylinders, the track and the cylinders being rotatable with respect to each other such that the undulating cam surface moves with respect to the open ends of the cylinders;

a piston movably disposed in each of the cylinders such that a combustion chamber is defined between the piston and the closed end of the cylinder, each piston being in mechanical communication with the cam surface of the track such that as the cylinders and track move with respect to each other, the pistons reciprocate within the cylinders between an upper position and a lower position; and

a variable compression ratio device operable to adjust the longitudinal position of the track with respect to the open ends of the cylinders such that the compression ratio of the engine is adjusted

rotating the track so as to position one of the pistons in the upper position;

continuing to rotate the track such that the one piston moves between the upper position and the lower position;

introducing a combustible mixture of air and fuel into the combustion chamber as the piston moves between the upper and the lower position;

continuing to rotate the track such that the one piston moves between the lower position and the upper position and the combustible mixture is compressed; and

adjusting the compression ratio until the compression of the combustible mixture is sufficient to cause the mixture to autoignite without the introduction of a spark, such that the mixture combusts; and

using the combustion of the mixture to move the piston between the upper position and the lower position, thereby causing the track to rotate.

31. The method according to 30, further comprising:

continuing rotating the track and repeating the introducing step; and

adjusting the compression ratio so as to generally avoid combustion prior to the piston reaching the upper position.

32. A corona discharge device for an internal combustion engine, the device comprising:

a corona discharge element configured to be disposed in the intake system of an internal combustion engine, the corona discharge element being operable when energized and disposed in air to ionize some of the gases in the air and to create free radicals.

33. An internal combustion engine with a corona discharge device, comprising:

an engine housing;

a combustion chamber defined in the housing;

an intake system operable to introduce air into the combustion chamber;

a corona discharge device disposed in the intake system, the corona discharge device operable to ionize gasses in the intake system and to create free radicals.

34. A method of adjusting mixture reactivity of a mixture in a combustion chamber in an internal combustion engine, comprising the steps of:

providing a corona discharge device operable to ionize gases and create free radicals when energized and disposed in the gases;

disposing the corona discharge device in air;

energizing the corona discharge device so as ionize some of the gases in the air and to create free radicals; and

introducing some of the ionized gases and free radicals into the combustion chamber so as to adjust the mixture reactivity of the mixture in the combustion chamber.

35. A homogenous charge compression ignition barrel engine comprising:

an engine housing having a first end and a second end;

a elongated power shaft longitudinally disposed in the engine housing and defining a longitudinal axis of the engine;

a plurality of cylinders surrounding the longitudinal axis, each cylinder having a closed end and an open end, each cylinder having a central axis, the open ends of the cylinders each being generally directed toward the first end of the housing;

an intake system operable to introduce a combustible mixture of air and fuel into each of the cylinders;

a corona discharge device operable to selectively create free radicals and ionize some of the air or the combustible mixture introduced into the cylinders so as to adjust the reactivity of the combustible mixture;

a track disposed between the first end of the housing and the open ends of the cylinders such that a portion of the track is disposed generally in alignment with the central axis of each of the cylinders, the track having a cam surface that longitudinally undulates with respect to the open ends of the cylinders, a portion of the cam surface being disposed generally in alignment with the central axis of each of the cylinders, the track and the cylinders being rotatable with respect to each other such that the undulating cam surface moves with respect to the open ends of the cylinders; and

a piston movably disposed in each of the cylinders such that a combustion chamber is defined between the piston and the closed end of the cylinder, each piston being in mechanical communication with the cam surface of the track such that as the cylinders and track move with respect to each other, the pistons reciprocate within the cylinders, each piston being operable to compress the combustible mixture until the mixture autoignites, without the introduction of a spark

36. The engine according to claim 35, wherein the corona discharge device is disposed in the intake system.

37. The engine according to claim 35, wherein the corona discharge device is disposed in at least one of the cylinders.

38. A method of controlling combustion phasing in a homogenous charge compression engine, comprising the steps of:

providing a homogenous charge compression engine of the type operable to compress a combustible mixture of fuel and air until the mixture autoignites without the introduction of a spark, the engine having at least one combustion chamber;

providing a corona discharge device operable to create free radicals and ionize gases when energized and disposed in the gases;

disposing the corona discharge in air;

selectively energizing the corona discharge device to create free radicals and ionize some of the gases in the air;

introducing some of the free radicals and ionized gases into the combustible mixture so as to alter the mixture reactivity of the combustible mixture and to adjust the combustion phasing of the engine; and

adjusting the energizing of the corona discharge device so as to control combustion phasing in the engine.

39. The method according to claim 39, wherein the engine includes an intake system operable to introduce the combustible mixture, the corona discharge device being disposed in the intake system.

40. The method according to claim 38, wherein the disposing step comprises disposing the corona discharge device in the combustible mixture of air and fuel.

41. A homogenous charge compression ignition barrel engine comprising:

an engine housing having a first end and a second end;

a elongated power shaft longitudinally disposed in the engine housing and defining a longitudinal axis of the engine;

a plurality of cylinders surrounding the longitudinal axis, each cylinder having a closed end and an open end, each cylinder having a central axis, the open ends of the cylinders each being generally directed toward the first end of the housing;

an intake system operable to introduce a combustible mixture of air and fuel into each of the cylinders;

a track disposed between the first end of the housing and the open ends of the cylinders such that a portion of the track is disposed generally in alignment with the central axis of each of the cylinders, the track having a cam surface that longitudinally undulates with respect to the open ends of the cylinders, a portion of the cam surface being disposed generally in alignment with the central axis of each of the cylinders, the track and the cylinders being rotatable with respect to each other such that the undulating cam surface moves with respect to the open ends of the cylinders;

a piston movably disposed in each of the cylinders such that a combustion chamber is defined between the piston and the closed end of the cylinder, each piston being in mechanical communication with the cam surface of the track such that as the cylinders and track move with respect to each other, the pistons reciprocate within the cylinders, each piston being operable to compress the combustible mixture; and

a rapid compression device operable to rapidly increase the compression level in one of the combustion chambers after the piston has at least partially compressed the mixture and to cause the combustible mixture to autoignite without the introduction of a spark.

42. The engine according to claim 41, wherein the rapid compression device comprises a movable member operable to change the volume of the combustion chamber.

43. The engine according to claim 42, wherein the movable member is a secondary piston disposed in the closed upper end of the cylinder.

44. The engine according to claim 41, wherein the rapid compression device comprises:

a body having a secondary chamber defined therein with an opening communicating between the secondary chamber and the combustion chamber;

an ignition device operable to ignite a combustible mixture in the secondary chamber; and

a gas permeable spark arrestor disposed in the opening such that an ignited combustible mixture in the chamber is extinguished as the mixture is forced through the arrestor.

45. The engine according to claim 44, wherein the ignition device is a spark plug.

46. The engine according to claim 44, wherein the rapid compression device comprises:

a system operable to inject hot gas into the combustion chamber.

47. The engine according to claim 41, wherein the rapid compression device comprises:

a system operable to capture a portion of the combustion product created by the first autoignition of the combustible mixture and to release the captured portion into a subsequent compressed combustible mixture to cause autoignition.

48. A rapid compression device for introducing a charge of hot gas into a combustion chamber in an internal combustion engine, the rapid compression device comprising:

a body having a chamber defined therein with an opening communicating with the chamber;

an ignition device operable to ignite a combustible mixture in the secondary chamber; and

a gas permeable spark arrestor disposed in the opening of the chamber such that an ignited combustible mixture in the chamber is extinguished as the mixture is forced through the arrestor.

49. An internal combustion engine comprising:

a main combustion chamber having an opening defined therein;

a secondary combustion chamber in gaseous communication with the opening in the main combustion chamber;

a ignition device in communication with the secondary combustion chamber for igniting a combustible mixture therein; and

a spark arrestor disposed in the opening in the main combustion chamber, the spark arrestor operable to pass gases therethrough and to extinguish combustion in the gases passed through the opening.

50. A method of introducing a charge of hot gas into a combustion chamber of an internal combustion engine, the method comprising the steps of:

providing an internal combustion engine having a combustion chamber defined therein;

providing a secondary chamber in gaseous communication with the combustion chamber;

introducing a combustible mixture of air and fuel into the secondary chamber;

combusting the mixture of air and fuel in the secondary chamber so as to produce a hot gaseous combustion product;

passing the combustion product from the secondary chamber to the combustion chamber; and

extinguishing the combustion product so as to create a hot gas as the combustion product passes from the secondary chamber to the combustion chamber;

whereby a hot gas is introduced into the combustion chamber.

51. The method according to claim 50, further comprising:

providing a spark ignition device in the secondary chamber, the device operable to introduce a spark into the secondary chamber; and

the combusting comprising introducing a spark from the spark ignition device to combust the mixture.

52. The method according to claim 50, further comprising:

providing a flame arrestor and the extinguishing step comprising passing the combustion product through the flame arrestor.

53. The method according to claim 50, wherein the combusting step comprises compressing the mixture in the secondary chamber until the mixture autoignites without the introduction of a spark.

54. A method of introducing pressurized gas into a combustion chamber, comprising:

providing an internal combustion engine having a combustion chamber;

introducing a mixture of air and fuel into the combustion chamber;

compressing the mixture of air and fuel in the combustion chamber;

combusting the mixture of fuel and air in the combustion chamber to create a pressurized gaseous combustion product;

capturing and holding a portion of the pressurized gaseous combustion product;

exhausting substantially all of the remainder of the gaseous combustion product out of the combustion chamber;

introducing a fresh mixture or air and fuel into the combustion chamber;

compressing the fresh mixture in the combustion chamber; and

releasing at least some of the held portion of the pressurized gaseous combustion product into compressed fresh mixture in the combustion chamber.

55. An internal combustion engine utilizing an HCCI combustion strategy, the engine comprising:

an engine housing

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark;

a first corona discharge device selectively operable to introduce ions and free radicals into the combustible mixture introduced into the first cylinder, thereby altering the mixture reactivity of the combustible mixture in the first cylinder and the combustion phasing for the first cylinder;

a second corona discharge device selectively operable to introduce ions and free radicals into the combustible mixture introduced into the second cylinder, thereby altering the mixture reactivity of the combustible mixture in the second cylinder and the combustion phasing for the second cylinder; and

a controller operable to control the first and second corona discharge devices so as to selectively adjust the relative combustion phasing of the first and second cylinders.

56. The engine according to claim 55, wherein the intake system includes a first runner for introducing the mixture into the first cylinder and a second runner for introducing the mixture into the second cylinder, the first corona discharge device being disposed in the first runner and the second corona discharge device being disposed in the second cylinder.

57. A method of controlling a homogenous charge compression ignition engine, comprising:

providing a homogenous charge compression ignition engine, comprising:

an engine housing

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark;

selectively introducing ions and free radicals into the combustible mixture in the first cylinder so as to adjust the mixture reactivity of the combustible mixture and the combustion phasing for the first cylinder;

selectively introducing ions and free radicals into the combustible mixture in the second cylinder so as to adjust the mixture reactivity of the combustible mixture and the combustion phasing for the second cylinder;

controlling the introduction of ions and free radicals to the first and second cylinders so as to selectively adjust the relative combustion phasing of the first and second cylinders.

58. An internal combustion engine utilizing an HCCI combustion strategy, the engine comprising:

an engine housing

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark;

a first water injector operable to selectively introduce water into the first cylinder, thereby altering the combustion phasing for the first cylinder;

a second water injector operable to selectively introduce water into the second cylinder, thereby altering the combustion phasing for the second cylinder;

a controller operable to control the first and second water injectors so as to selectively adjust the relative combustion phasing of the first and second cylinders.

59. A method of controlling a homogenous charge compression ignition engine, comprising:

providing a homogenous charge compression ignition engine, comprising:

an engine housing

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark;

selectively introducing water into the first cylinder so as to adjust the combustion phasing for the first cylinder;

selectively introducing water into the second cylinder so as to adjust the combustion phasing for the second cylinder;

controlling the introduction of water into the first and second cylinders so as to selectively adjust the relative combustion phasing of the first and second cylinders.

60. An internal combustion engine utilizing an HCCI combustion strategy, the engine comprising:

an engine housing

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark;

a first cooling system operable to selectively cool the first cylinder, thereby altering the combustion phasing for the first cylinder;

a second cooling system operable to selectively cool the second cylinder, thereby altering the combustion phasing for the second cylinder;

a controller operable to control the first and second cooling systems so as to selectively adjust the relative combustion phasing of the first and second cylinders.

61. The internal combustion engine according to claim 60, wherein:

the first cooling system comprises a first coolant supply, first coolant jacket at least partially surrounding the first cylinder and a first coolant control valve for controlling a flow of coolant from the first coolant supply through the first coolant jacket; and

the second cooling system comprises a second coolant supply, a second coolant jacket at least partially surrounding the second cylinder and a second coolant control valve for controlling a flow of coolant from the second coolant supply through the second coolant jacket.

62. A method of controlling a homogenous charge compression ignition engine, comprising:

providing a homogenous charge compression ignition engine, comprising:

an engine housing

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark;

selectively cooling the first cylinder so as to adjust the combustion phasing for the first cylinder;

selectively cooling the second cylinder so as to adjust the combustion phasing for the second cylinder;

controlling the cooling of the first and second cylinders so as to selectively adjust the relative combustion phasing of the first and second cylinders.

63. An internal combustion engine utilizing an HCCI combustion strategy, the engine comprising:

an engine housing;

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders, the intake system comprising a first fuel injector for providing fuel for the combustible mixture for the first cylinder and a second fuel injector for providing fuel for the combustible mixture for the second cylinder, the combustible mixture for the first cylinder having a first air-fuel ratio and the combustible mixture for the second cylinder having a second air-fuel ratio;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark; and

a controller operable to control the first and second fuel injectors so as to selectively adjust the air-fuel ratio for the first and second cylinder to adjust the relative combustion phasing of the first and second cylinders.

64. A method of controlling a homogenous charge compression ignition engine, comprising:

providing a homogenous charge compression ignition engine, comprising:

an engine housing

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders, the intake system comprising a first fuel injector for providing fuel for the combustible mixture for the first cylinder and a second fuel injector for providing fuel for the combustible mixture for the second cylinder, the combustible mixture for the first cylinder having a first air-fuel ratio and the combustible mixture for the second cylinder having a second air-fuel ratio;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark;

controlling the first and second fuel injectors so as to selectively adjust the air-fuel ratio for the first and second cylinder to adjust the relative combustion phasing of the first and second cylinders.

65. A method of controlling a homogenous charge compression ignition engine, comprising:

providing a homogenous charge compression ignition engine, comprising:

an engine housing

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark; and

controlling the temperature of the combustible mixture introduced into the first and second cylinders so as to adjust the relative combustion phasing of the first and second cylinders.

66. The method according to claim 65, wherein the temperature controlling step comprises selectively warming the air in the combustible mixture.

67. The method according to claim 65, wherein the temperature controlling step comprises selectively mixing warm and cool air for the combustible mixture.

68. A method of controlling a homogenous charge compression ignition engine, comprising:

providing a homogenous charge compression ignition engine, comprising;

an engine housing

a first and a second cylinder defined in the engine housing;

an intake system operable to introduce a combustible mixture of air and fuel into the cylinders;

a first piston disposed in the first cylinder operable to compress the combustible mixture in the first cylinder until the mixture autoignites without the introduction of a spark;

a second piston disposed in the second cylinder operable to compress the combustible mixture in the second cylinder until the mixture autoignites without the introduction of a spark;

providing an exhaust gas recirculation system operable to selectively introduce exhaust gas into the combustible mixture introduced into the first and second cylinders; and

controlling the exhaust gas recirculation system to selectively control how much exhaust gas is introduced into the combustible mixture introduced into the first and second cylinders so as to adjust the relative combustion phasing of the first and second cylinders.

69. A homogenous charge compression ignition barrel engine comprising:

an engine housing having a first end and a second end;

a elongated power shaft longitudinally disposed in the engine housing and defining a longitudinal axis of the engine;

a plurality of cylinders surrounding the longitudinal axis, each cylinder having a first and an opposed second open end, each cylinder having a central axis, the first open ends of the cylinders each being generally directed toward the first end of the housing and the second open ends being generally directed toward the second end of the housing;

an intake system operable to introduce a combustible mixture of air and fuel into each of the cylinders;

a first track disposed between the first end of the housing and the first open ends of the cylinders such that a portion of the track is disposed generally in alignment with the central axis of each of the cylinders, the track having a cam surface that longitudinally undulates with respect to the first open ends of the cylinders, a portion of the cam surface being disposed generally in alignment with the central axis of each of the cylinders, the track and the cylinders being rotatable with respect to each other such that the undulating cam surface moves with respect to the first open ends of the cylinders;

a second track disposed between the second end of the housing and the second open ends of the cylinders such that a portion of the track is disposed generally in alignment with the central axis of each of the cylinders, the track having a cam surface that longitudinally undulates with respect to the second open ends of the cylinders, a

portion of the cam surface being disposed generally in alignment with the central axis of each of the cylinders, the track and the cylinders being rotatable with respect to each other such that the undulating cam surface moves with respect to the second open ends of the cylinders; and

a first and a second piston movably disposed in each of the cylinders such that a combustion chamber is defined between the first and second pistons, each first piston being in mechanical communication with the cam surface of the first track such that as the cylinders and first track move with respect to each other, the first pistons reciprocate within the cylinders, each second piston being in mechanical communication with the cam surface of the second track such that as the cylinders and second track move with respect to each other, the second pistons reciprocate within the cylinders, the pistons being operable to compress the combustible mixture until the mixture autoignites, without the introduction of a spark.

70. A homogenous charge compression ignition engine comprising:

an engine housing;

a plurality of chambers each having a first and a second open end;

an intake system operable to introduce a combustible mixture of air and fuel into each of the chambers; and

a first and a second piston movably disposed in each of the cylinders such that a combustion chamber is defined between the first and second pistons; the pistons being operable to compress the combustible mixture until the mixture autoignites, without the introduction of a spark.

71. A method of sensing combustion phasing in a homogenous charge compression engine comprising:

providing a knock sensor for producing a signal representing the sound and/or vibration from the engine;

correlating the signal from the knock sensor with the combustion phasing of the engine; and

using the correlated signal to determine the combustion phasing of the engine.